Ontario Geological Survey

Northern Ontario
Engineering Geology Terrain Study 88

WESTREE AREA

(NTS 41P/SW)

Districts of Sudbury and Timiskaming

Compliments of
ONTARIO
MINISTRY OF NORTHERN DEVELOPMENT
AND MINES
Not for resale

by
M.A. Roed and D.R. Hallett

1978

Ontario

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THIS PROJECT WAS FUNDED BY
THE ONTARIO MINISTRY OF NORTHERN AFFAIRS
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THE ONTARIO MINISTRY OF NATURAL RESOURCES

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Orders for publications should be accompanied by cheque or money order payable to the *Treasurer of Ontario.*

ISSN 0709-4671
ISBN 0-7743-4364-8

Parts of this publication may be quoted if credit is given. It is recommended that reference to this report be made in the following form:

Roed, M. A. and Hallett, D. R.

1979: Westree Area (NTS 41P/SW), Districts of Sudbury and Timiskaming; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 88, 17p. Accompanied by Map 5022, scale 1:100 000.

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MAP
(accompanying report)

Map 5022 (coloured) – Northern Ontario Engineering Geology Terrain Study, Data Base Map, Westree (NTS 41P/SW). Scale 1:100 000.

Northern Ontario

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WESTREE AREA

(NTS 41P/SW)

Districts of Sudbury and Timiskaming

by

M. A. Roed[1] and D. R. Hallett[2]

1.0 INTRODUCTION:

This report contains an inventory of regional engineering terrain conditions in the Westree area, Districts of Sudbury and Timiskaming. It forms part of a series of publications which provide similar terrain data for some 370 000 km^2 of northern Ontario.

The area, which covers NTS block 41P/SW, lies between Latitudes 47°00′N and 47°30′N and Longitudes 81°00′W and 82°00′W. Forestry is the major economic activity in this sparsely populated region. Tourism and mineral exploration are important seasonal activities.

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Manuscript approved for publication by the Chief, Engineering and Terrain Geology Section, August 28, 1979. This report is published with the permission of E. G. Pye, Director, Ontario Geological Survey.

1.1 TERRAIN MAPPING PROGRAM:

The purpose of the mapping is to provide a guide for engineering and resource planning functions at a level of detail consistent with a scale of 1:100,000. The terrain information is contained on the Data Base Map (OGS Map 5022, accompanying this report).

Interpretation of black and white aerial photographs, at a scale of approximately 1:50,000, was the primary method of obtaining this terrain data. The interpretation includes information from relevant published literature, and the main roads in the area were traversed during the summer of 1977 to provide spot checks on the photogeologic interpretation. Thus, the map represents a reconnaissance overview of the engineering conditions of the terrain.

An engineering terrain legend was developed to facilitate the mapping and to provide a common information base for the entire map series. This legend is shown on the accompanying Data Base Map. Further information on the mapping techniques, legend format, and possible uses of this data is available in the "Ontario Engineering Geology Terrain Study Users' Manual" (Gartner, Mollard and Roed, in preparation), a companion publication to this series of maps and reports.

1.2 PREVIOUS WORK:

The surficial deposits have been mapped or considered on a reconnaissance basis by Boissonneau (1965, 1968), Prest (1969, 1970), Prest *et al.* (1967), Hughes (1965), the Ontario Land Inventory (1976), Skinner (1969), Dean (1956), and the Canada Land Inventory (1971). Regional bedrock geology has been compiled by Card and Lumbers (1977) and preliminary detailed geologic maps are available, for certain parts of the map-area, from the Ontario Geological Survey. The mineral potential has been summarized by Springer (1977).

2.0 GEOLOGIC SETTING:

In the Westree area, a discontinuous mantle of Quaternary deposits overlies crystalline bedrock of Precambrian age. The terrain is characterized by a variety of extensive terrain units, including bedrock, morainal, glaciofluvial, and eolian types.

Distinctive geologic features in this area include the Sultan Scarp (Roed 1979), a possible remnant of the last major glacial stillstand in the area, and extensive outwash plains which have been reworked by eolian processes.

2.1 BEDROCK GEOLOGY:

The area is underlain by a variety of Precambrian rocks and straddles the boundary between the Superior and Southern Structural Provinces of the Canadian Shield. A poorly delineated belt of Middle Precambrian Cobalt Group sedimentary rocks occupies the eastern third of the area, while the remainder is dominated by granitic and migmatitic rocks. Middle Precambrian (Nipissing) gabbroic intrusives and minor amounts of Early Precambrian (Archean) mafic to intermediate metavolcanics are associated with the Cobalt sediments. Numerous faults occur throughout the area (Card and Lumbers 1977).

Mineral potential is poor or unknown throughout the area, although scattered occurrences of lead, zinc, silver, copper, and iron have been found (Springer 1977).

2.2 QUATERNARY GEOLOGY:

Northern Ontario was glaciated by continental ice sheets at least four times during the Pleistocene. However, only the deposits of the last glaciation, the Laurentide of Wisconsinan age, are preserved in the Westree area.

The Keewatin lobe of the Laurentide ice sheet advanced from the northeast at the beginning of the Wisconsinan (approximately 100 000 years ago) and eventually extended as far south as Minnesota. By late Wisconsinan time (approximately 11 000 years ago) the ice had receded to the

Westree area and deposited a variety of surficial materials. The glacier may have disappeared completely from the area at this time and then readvanced to the position presently marked by the Sultan Scarp, or, more likely, it formed the Sultan Scarp during a halt in its recession. In either event, the Sultan Scarp is clearly recognized as the only major stillstand of this ice sheet in the map-area. The morainal scarp is bounded on the south by an extensive glaciofluvial outwash plain which represents a substantial outflow of meltwater from a wide front. Much of this meltwater escaped to the west along the valley presently occupied by the Cow River and further west by the Montreal River, and to the south along the Wenebegon River (Roed and Hallett 1979). During the final phase of this event, drainage in one or more of the meltwater channels must have been blocked, resulting in ponding for a brief time, since raised beaches occur in some places on the surface of the outwash plain south of the Sultan Scarp. Other important glacial deposits include ground moraine till, deposited directly by the ice, and esker and kame complexes deposited by meltwater in contact with the ice.

Deglaciation of some parts of the map-area occurred by mass disintegration of the ice. Evidence of this is provided by the occurrence of hummocky moraine and pitted outwash plains. Local ponding occurred, but most of the outwash sand deposits exhibit sedimentary structures that indicate deposition in slow-moving water. These deposits could generally be interpreted as lacustrine in origin, as in the case of Lake Sultan, described by Boissonneau (1968).

By approximately 9 000 years ago the area was probably ice-free and, for a time, much of the landscape was affected by eolian activity. Modern streams became established and alluvium was deposited. Organic terrain developed in poorly drained depressions. These non-glacial deposits, together with the various glacial deposits, complete the spectrum of Quaternary unconsolidated materials that form a discontinuous mantle over the bedrock.

2.3 PHYSIOGRAPHY:

Local relief in the Westree map-area is generally low on the glaciofluvial and eolian deposits and moderate on the morainal and bedrock terrain. Elevations (above sea level) range from less than 366 m along the Wanapitei River close to the eastern boundary of the area to 610 m immediately west of Welcome Lake in the same vicinity.

3.0 ENGINEERING TERRAIN UNITS:

Engineering terrain units are composed of a combination of various materials (unconsolidated and/or bedrock) which form recognizeable landforms with certain engineering characteristics. Major terrain unit groups, and the engineering significance of each, are discussed in detail. These include bedrock terrain (RN), moraine (MG,MH), glaciofluvial outwash (GO), eskers (GE), and kames (GK), and eolian deposits (ED). Less significant terrain units include alluvium (AP) and organic terrain (OT). Diagrammatic sketches of typical terrain settings are given in Figure 1. Table 1 summarizes the composition, topography and drainage of all major terrain units and rates each unit in terms of important soil characteristics according to engineering criteria and in terms of suitability for principal engineering uses.

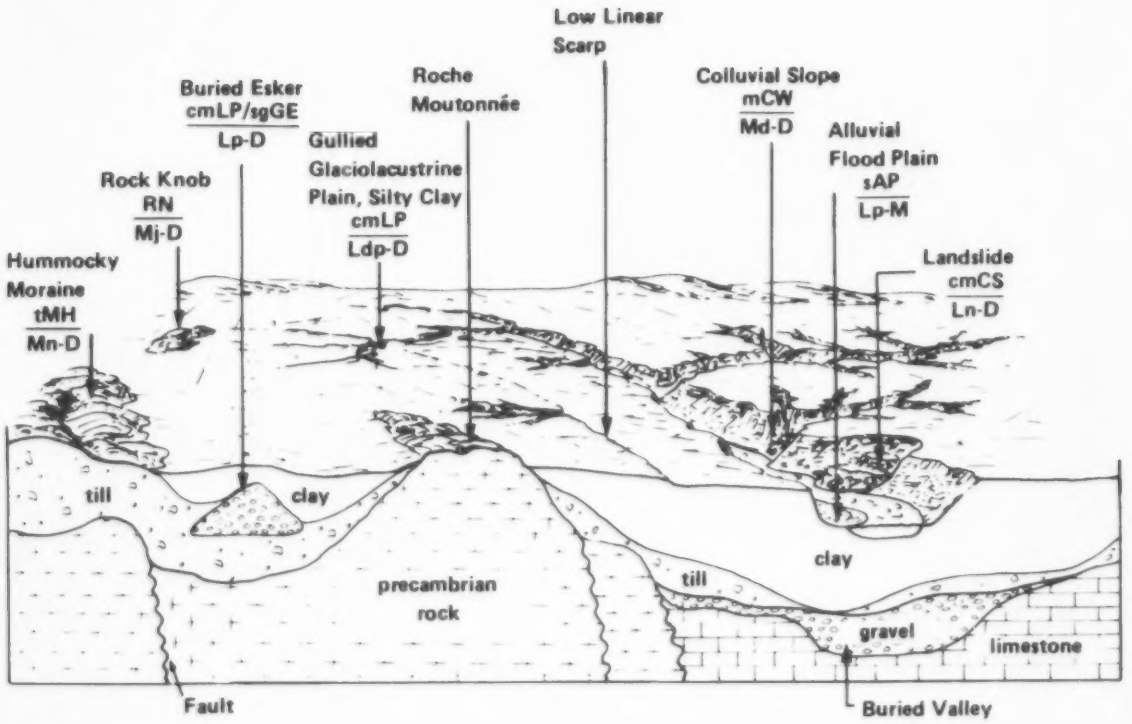
3.1 BEDROCK:

Examples:

$$\frac{\text{RN(tMG)}}{\text{Mn-D}} \qquad \frac{\text{RN(tMG)(sGO)}}{\text{Mun-D}} \qquad \frac{\text{RN(tMG)(pOT)}}{\text{Mjn-D(D)(W)}} \qquad \frac{\text{RN(tMG)(pOT)}}{\text{Lu-D(D)(W)}}$$

Bedrock terrain, which occurs extensively throughout the southern half of the map-area, constitutes ground that is underlain mainly by bedrock, either at surface or within 1 to 2 m of the surface. There is very little overburden in this unit except for patches of ground moraine (MG) and, glaciofluvial outwash (GO), and deposits of organic terrain (OT) in poorly drained depressions. Small eskers, crevasse fillings, and drumlins also occur. Most of the bedrock terrain is of moderate relief (M) and is undulating (u) to rugged (j) in character. Some low (L) and high (H) relief rock terrain occurs in the north-central and eastern parts of the map-area respectively. Drainage is generally good (D) except in organic depressions.

The principal engineering significance of bedrock terrain is that it is difficult and expensive to excavate. Blasting is required for all subsurface excavations. Extensive cut-and-fill operations are required in rugged terrain for transportation route construction, in order to eliminate extreme horizontal and vertical alignments. Many small sand, gravel,


Low Linear
Scarp
Buried Esker
cmLP/sgGE
Lp-D
Roche
Moutonnée
Colluvial Slope
mCW
Md-D
Alluvial
Flood Plain
sAP
Lp-M
Rock Knob
RN
Mj-D
Gullied
Glaciolacustrine
Plain, Silty Clay
cmLP
Ldp-D
Hummocky
Moraine
tMH
Mn-D
Landslide
cmCS
Ln-D
till
clay
precambrian
rock
clay
till
gravel
limestone
Fault
Buried Valley

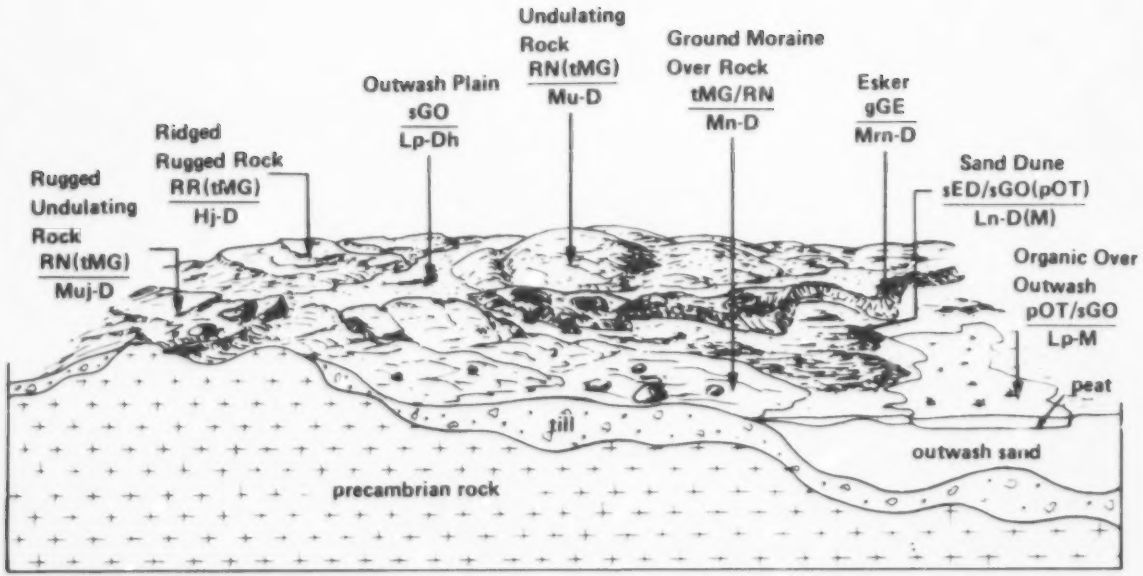


FIGURE 1 – DIAGRAMMATIC SKETCHES SHOWING TYPICAL TERRAIN TYPES AND THEIR REPRESENTATIVE LETTER SYMBOLS.

TABLE 1 SUMMARY OF TERRAIN UNIT CHARACTERISTICS AND ENGINEERING SIGNIFICANCE.

Terrain Unit	Principal Materials	Topography / Drainage	Workability as Construction Material / Permeability	Shearing Strength / Bearing Value	Compaction / Compressibility
Rock Terrain (R)	rock	irregular / dry	not applicable / medium (fracture)	excellent / excellent	not applicable / not applicable
Hummocky Moraine (MH)	till, sand boulders	hummocky / dry	good / medium	good / good	good / low
Ground Moraine (MG)	till, sand boulders	knobby / dry	good / medium	good / good	good / low
Eskers (GE) Kame (GK)	sand gravel	kettled & ridged / dry	excellent / high	excellent / excellent	excellent / low
Outwash (GO) Delta (GD)	sand, gravel	hummocky-planar / dry	excellent / high	excellent / excellent	excellent / low
Glaciolacustrine Plain (LP)	clay, silt fine sand	planar / dry	poor / low	fair / fair	poor / high
Glaciolacustrine Beach (LB)	sand	planar / dry	good / high	good / good	good / low
Alluvium (AP)	sand, silt clay	channelled / mixed	fair / medium	good / poor	fair / medium
Eolian (ED)	sand	ridged, hummocky / dry	fair / high	good / good	good / low
Colluvium Soil (CW,CS)	clay, silt	sloped / mixed	poor / low	poor / poor	poor / high
Colluvium Talus (CT)	rubble	sloped / dry	poor / high	good / poor	poor / low
Organic (OT)	peat	planar / wet	poor / medium	poor / poor	poor / high

Notes:
1. The rating above or below the bar refers to the characteristic or use above or below the bar, respectively, in the column heading.
2. Permeability, compressibility, and frost susceptibility are rated as low, medium, or high; all other characteristics and uses are rated as poor, fair, good, or excellent.

Slope Stability / Frost Susceptibility	Aggregate Supply / Foundations	Highway Subgrade / Route Location	Hydro Easements / Pipeline Routes	Septic Tank Suitability / Solid Waste Landfill	Domestic Groundwater Potential / Large Groundwater Supplies
good (some talus) / not applicable	not applicable / excellent	poor / fair	fair / poor	poor / poor	good / poor
good / low	fair / good	good / good	good / good	excellent / excellent	excellent / good
good / low	fair / good	good / good	fair / fair	excellent / good	good / fair
excellent / low	excellent / excellent	excellent / excellent	good / good	poor / poor	excellent / excellent
excellent / low	excellent / excellent	excellent / excellent	excellent / excellent	poor / poor	excellent / excellent
poor / high	poor / fair	poor / good	good / good	fair / fair	fair / poor
excellent / low	good / good	good / good	good / good	poor / poor	good / poor
fair / medium	poor / poor	poor / poor	poor / poor	poor / poor	good / fair
good / low	poor / good	fair / good	good / good	fair / poor	good / fair
poor / high	poor / poor	poor / poor	poor / poor	poor / poor	fair / poor
good / low	poor / poor	poor / poor	poor / poor	poor / poor	poor / poor
poor / high	poor / poor	poor / poor	poor / poor	poor / poor	poor / poor

3. This is a generalized table intended for use in a number of reports; therefore, all terrain units dealt with in the table will not necessarily appear in each report.

and till deposits scattered throughout the terrain provide adequate material for minor access road construction. However, for major transportation routes, aggregate is often imported from considerable distances at high costs.

Bedrock terrain provides excellent foundation conditions in areas that are unaffected by faults and where fractures or joint density is low. The unit also possesses considerable potential for aggregate obtained in rock quarry operations.

Groundwater potential is generally poor in bedrock terrain, but is usually sufficient for scattered domestic demand. Considerable groundwater production can be expected in fractured localities or in fault zones. Bedrock is unsuitable for waste disposal except where a thick layer (at least 1.5 m) of soil material is present.

3.2 MORAINE:

Examples:

$$\frac{\text{tMG(RN)(pOT)}}{\text{Mn-D(D)(W)}} \qquad \frac{\text{tMG(RN)(pOT)}}{\text{Ldu-D(D)(W)}} \qquad \frac{\text{tMH(pOT)(RN)}}{\text{Mn-D(W)(D)}} \qquad \frac{\text{tsMH(RN)}}{\text{Ln-D}}$$

Morainal landforms in this map-area are either ground moraine (MG) or hummocky moraine (MH). Ground moraine (MG) consisting of sandy till (ts) occurs throughout the map-area as a major terrain unit or as a subordinate unit in bedrock terrain. The till varies from 1 m to more than 7 m in thickness and commonly occupies rolling terrain of moderate (M) relief with undulating (u) to slightly knobby (n) topographic character. The overall drainage is good (D). Low, rounded rocky hills (RN) and near-surface bedrock (/R) occur within the ground moraine, as does organic terrain (OT) in poorly drained depressions (W). Patches of glaciofluvial sand and gravel, eskers, kames, and hummocky moraine are also associated with the ground moraine. Geological contacts with these units are normally abrupt, except in the case of hummocky moraine and rock terrain where the contacts are often gradational.

Hummocky moraine (MH) also consists of sandy till (ts) and is scattered throughout the map-area. The thickness of the till is much more variable than in ground moraine and may be as much as 30 m in some localities.

Although till (t) is the principal material, stratified sand (s) and gravel (g), pockets of silt (m), and local concentrations of boulders (b) occur in places. Outwash, eskers, kames, crevasse fillings, bedrock knobs, and organic deposits are commonly associated with the hummocky moraine. Local relief varies from low (L) to moderate (M) and the character of the surface is knobby (n), undulating (j), and sometimes kettled (k). Drainage is good except in closed depressions between knobs of till and along poorly developed seepage paths.

Large boulders, patches of poorly drained ground, and the possibility of near-surface bedrock are the principal engineering difficulties that may be encountered in the ground moraine unit. Generally, however, ground moraine poses few serious construction problems and is superior to bedrock terrain for route construction because grades are lower and the necessity for rock blasting is less probable. Pockets of granular material occur, and the till itself is amenable to beneficiation in some localities. Foundation conditions are generally good in till terrain. Groundwater potential is fair where the till unit attains an adequate thickness. Where the till is at least 1.5 m thick, it is suitable for septic system installation.

The engineering significance of the hummocky moraine is substantial. The texture of the till makes the unit suitable for use in the large earth embankments required for roads and dams. Also, the chance of finding a sizeable source of granular material within hummocky moraine is good. Conventional construction techniques can be used throughout, except where local relief is very irregular, where local accumulations of large boulders occur, or where near-surface bedrock is encountered. The till in hummocky moraine is probably the best material in the map-area for attenuation of leachate from municipal landfills and septic drain tile fields. Groundwater potential, although inconsistent, is generally good; springs are common at the base of large morainal hills, especially during wet periods of the year.

3.3 GLACIOFLUVIAL:

Examples:

$$\frac{\text{sgGO}}{\text{Lp-D}} \qquad \frac{\text{sgGO(pOT)}}{\text{Ldp-D(M)}} \qquad \frac{\text{sgGO}}{\text{Lkp-D}} \qquad \frac{\text{sgGO(RN)(sED)}}{\text{Lp-M}}$$

$$\frac{sgGO(sAP)}{Lt\text{-}D(Dh)} \qquad \frac{sgGE}{Lkn\text{-}D} \qquad \frac{sgGK}{Lnk\text{-}D} \qquad \frac{sgGE}{Ln\text{-}D}$$

Large tracts of land in the Westree map-area are underlain by glaciofluvial outwash (GO) composed of sand (s) and gravel (g). Most outwash occurs in the form of undulating (u) to knobby (n) plains (p) of low relief (L) that are sometimes dissected (d), kettled (k), and pitted. Drainage is generally good (D), but a high water table (h) is occasionally encountered. Often the upper 2 m of the deposit consists of fine- to coarse-grained sand. This is underlain by stratified pebble to cobble gravel which, in places, is probably greater than 5 m thick. Interbedded sand and gravel layers may occur at depth. The maximum thickness of this outwash unit may be in the order of 40 m, especially in the southern part of the map-area (close to the Sultan Scarp); this estimate of thickness is based on the extent of the unit and the fact that rock terrain with relief in this range has been completely covered. Much of the outwash closest to, and south of, the Sultan Scarp is overlain by eolian sand (ED). Other associated subordinate landforms include eskers, kames, bedrock knobs (RN), and organic peat deposits (pOT) in wet depressions (W).

Three esker complexes have been identified in the Westree map-area, two of which are located in the northwestern corner. The eskers occur as southward-trending, continuous or discontinuous, sinuous, hummocky to rolling ridges of sand and gravel flanked by gently rolling outwash plains and hummocky terrain. Local relief on an esker is usually in the order of 10 to 15 m; pits, kettle lakes, and isolated steep-sided knobs are common. Most of the eskers appear to be composed of sand and gravel in more or less equal proportions, but minor till inclusions and an upper mantle of till occur in places. In the esker core and also where the slopes are steep, gravel is usually the dominant constituent. Smaller eskers occur in association with glaciofluvial outwash deposits and bedrock terrain. Some less prominent eskers may have buried extensions.

Kames consist of irregular groupings of hills composed of sand, gravel, and till. These landforms differ from eskers in that they are not ridge-like and the internal composition is more heterogenous and variable. Otherwise they are similar to eskers. Notable kame complexes occur north of Three Corner Lake and west of Dividing Lake, close to the Sultan Scarp on the northern boundary of the area.

Eskers and kames are generally well-drained, but do include minor patches of poorly drained organic terrain in local depressions. Buried eskers are well drained on the surface, but commonly have a high water table.

The engineering significance of glaciofluvial outwash, eskers, and kames is related to the excellent characteristics of the materials with respect to use in construction. Potential reserves of aggregate are extremely high in the northern portion of the area. Transportation routes, pipelines, and air strips are easily constructed on the flat outwash plains. Most existing transportation routes in this map-area have taken advantage of this fact. Eskers also have potential as transportation routes, although the sinuous form and some steep topography are disadvantages. Foundation and general construction conditions are excellent in glaciofluvial terrain. Groundwater potential is excellent where the deposits are thick and/or where the table is high. Glaciofluvial deposits are not suitable for waste disposal since the materials are permeable and the potential for pollution is high.

3.4 EOLIAN:

Examples:

$$\frac{\text{sED(pOT)}}{\text{Lp-M}} \qquad \frac{\text{sED/sGO(pOT)}}{\text{Lp-D(M)}} \qquad \frac{\text{sED(pOT)(RN)}}{\text{Lp-M}} \qquad \frac{\text{sED(pOT)}}{\text{Ln-D(M)}}$$

Eolian deposits (ED) of fine sand (s) occur in some parts of the map-area. The wind-blown deposits are derived mainly from glaciofluvial sand and occur as U-shaped dunes, small hills, and ridges. The deposits generally form a discontinuous blanket over other terrain units, most often outwash (GO), but also moraine and organic deposits. Local relief in dune fields ranges from 2 to 5 m, which is also the approximate thickness of these deposits.

The largest dune field is situated north of the Wanapitei River in the northeastern part of the area. Here, U-shaped dunes and transverse ridges are all stabilized by vegetation and most are oriented in a southeasterly direction, indicating a prevailing northwest wind at the time of dune formation. Blanket sand is up to 1 m thick and occurs as a discontinuous mantle in the dune field and the adjacent terrain units.

Much of the eolian sand shown on the outwash deposit south of the Sultan Scarp is blanket sand. Drainage in the eolian terrain unit varies from good to mixed (D-M) with a high water table (h) in places, especially between some dunes.

Access roads are constructed very easily in eolian terrain, but the erosion potential is high once the protective vegetation cover has been removed. A high water table may limit excavation in places, and slumping and piping can occur. Driven well points will supply enough water for domestic use in eolian deposits below the water table. The pollution potential is high.

3.5 ALLUVIUM:

Examples:

$$\frac{\text{spAP}}{\text{Lp-Dh}} \qquad \frac{\text{spAP}}{\text{Lp-W}}$$

Alluvial plains (AP) composed of sand (s), silt (m) and peat (p) occur along most river channels, but many are too small to map at the scale of 1:100,000.

Alluvial deposits that have been mapped include those along the Wanapitei, Donnegana and Opikinimikea Rivers. Relief is low (L) and drainage is most often west (W) with a high water table (h).

Foundation conditions are generally poor in alluvial terrain since materials are fine grained and water saturated. Structures built on alluvial plains will be subject to flooding and would require suitable protection. Erosion potential and slope instability are high along stream banks. Groundwater potential is good in gravelly materials and poor in fine grained materials. Alluvium is not suitable for waste disposal because of periodic flooding and the potential for pollution.

3.6 ORGANIC:

Examples:

$$\frac{pOT}{Lp\text{-}W} \qquad \frac{pOT(sGO)}{Lp\text{-}M} \qquad \frac{pOT(sED)}{Lp\text{-}M}$$

Organic terrain (OT) composed primarily of peat (p), with some silt (m) and sand (s), occurs throughout the map-area in isolated poorly drained (W) depressions within other terrain units. Large organic deposits were mapped north of the Spanish River in the western part of the area and northeast of Threecorner Lake in the northern part of the area. Organic terrain occurs extensively as a subordinate landform in eolian terrain in the eastern part of the area.

Construction is difficult and expensive in organic terrain due to the poor drainage conditions and the low strength, low bearing capacity, high compressibility, and extremely high frost susceptibility of the soil materials. Groundwater in organic deposits is generally of poor quality and unsuitable for drinking. Septic drain tile fields should not be placed in organic terrain.

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MAPS
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